

1. 28. SOLAR / 1029 - 79 / 05

Alpha 1215968

SOLAR/1029-79/05

Monthly Performance Report

DESIGN CONSTRUCTION

MAY 1979



U.S. Department of Energy

National Solar Heating and
Cooling Demonstration Program

National Solar Data Program

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, nor any of their contractors, subcontractors, or their employees, make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

MONTHLY PERFORMANCE REPORT

DESIGN CONSTRUCTION

MAY 1979

I. SYSTEM DESCRIPTION

The Design Construction site is a single-family residence in Bigfork, Montana. The home has approximately 1800 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 792 square feet. The array faces south at an angle of 45 degrees to the horizontal. Water is the transfer medium that delivers solar energy from the collector array to storage and from storage to the space heating and hot water loads. This water is drained from the collector when the collector pump is not operating. Solar energy is stored in a 1400-gallon water tank located in the conditioned space. The cylindrical tank has 6-inch concrete walls with 2-inch expanded polyurethane insulation. Preheated city water is stored in a 65-gallon DHW tank. When solar energy is insufficient to satisfy the space heating load, an electrical heating element in the boiler provides auxiliary energy for space heating. Similarly, an electrical heating element in the DHW tank provides auxiliary energy for water heating. Solar energy in the storage tank is supplemented by auxiliary energy provided by a hydro-heater fireplace which has a heat-exchanger water jacket around the chimney. When the fireplace is used, water is circulated from the storage tank through the fireplace and chimney heat exchanger, thereby accumulating additional energy which is returned to the storage tank. Energy from the storage tank is transferred to the DHW tank through an in-tank heat exchanger. Hot water used for space heating is passed from storage through the electric boiler and then through a four-zone hydronic heating system. Two fans are installed in the small enclosed chamber above the fireplace in which the fireplace pump (P4) and the fireplace control sensor are located. These fans are used to cool the chamber ambient and to circulate the warm chamber air into the living space. Both fans operate in parallel with the fireplace pump. The system, shown schematically in Figure 1, has four modes of solar operation, each of which is independent of the others.

- 1001 COLLECTOR PLANE TOTAL INSOLATION
- T001 OUTDOOR TEMPERATURE
- T600 INDOOR TEMPERATURE

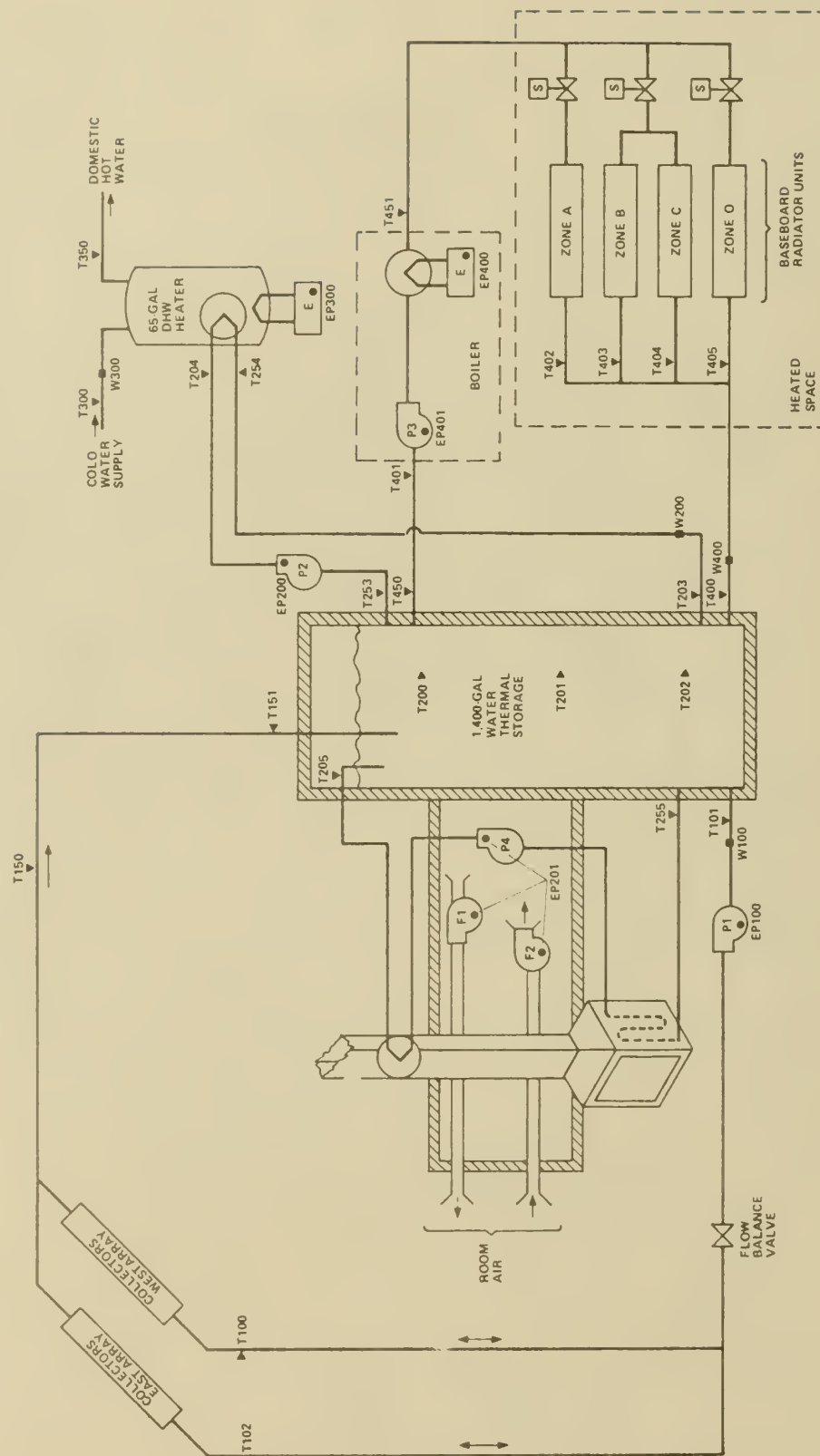


Figure 1. DESIGN CONSTRUCTION ASSOCIATES SOLAR ENERGY SYSTEM SCHEMATIC

Mode 1 - Collector-to-Storage: This mode activates when there is a temperature difference of 9°F between the control sensor located in the collector and the control sensor in the storage tank. Water is circulated from the storage tank through the collector and back to the tank. This circulation continues until the temperature difference between the two control sensors decreases to 3°F, at which point the circulating pump turns off. When the pump stops operating, water is drained from the collector and returned to the storage tank.

Mode 2 - Storage-to-Space Heating: This mode activates when any of the four zones demand space heating. The thermostat of the zone demanding heat will activate the solenoid-operated control valve for that zone. The thermostat will also activate the circulating pump to allow heated water to circulate from the storage tank, through the boiler, to the appropriate zone (via its control valve) and back to the storage tank. Water continues to circulate as long as any zone demands heat. The electric boiler will provide auxiliary energy if the temperature of the water circulating through the boiler drops below 110°F (set point). When the space heating demand is satisfied, the circulating pump turns off and all open-zone control valves close.

Mode 3 - Storage-to-DHW Heat Exchanger: This mode activates when the temperature difference between a control sensor in the storage tank and a control sensor on the surface of the DHW tank reaches 9°F and terminates when the temperature difference drops to 5°F. If the water temperature in the hot water tank falls below the setting of its thermostat, the electric immersion heater turns on to provide auxiliary energy to the water in the hot water tank. This mode also terminates if the temperature in the storage tank, as indicated by another control sensor in the storage tank, falls below 80°F (set point).

Mode 4 - Fireplace-to-Storage: This mode activates when there is a temperature difference of 9°F between a control sensor located in the fireplace and another control sensor in the storage tank. (This occurs when the fireplace is being used.) The pump turns on to circulate water from the storage tank through the fireplace and the chimney heat exchanger, thereby accumulating

energy which is returned to storage. This mode continues until the temperature difference between the two control sensors drops to 3°F, at which point the pump turns off and the mode terminates. Both fans in the enclosed chamber above the fireplace also operate in parallel with the pump while in this mode.

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was occupied in May and the solar energy system operated continuously during the month. Total solar energy collected was 10.9 million Btu and the total solar energy used was 3.8 million Btu or 35 percent of the collected energy. The change in stored energy was 0.19 million Btu and the total system losses amounted to 9.4 million Btu. Solar energy satisfied 94 percent of the DHW requirements and 93 percent of the space heating requirements. The solar energy system provided an electrical energy savings of 3.5 million Btu. The performance factors are discussed below and are presented in the accompanying report forms.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 36.9 million Btu for a daily average of 1505 Btu per square foot. This was below the estimated average daily solar radiation for this geographical area during May of 1534 Btu per square foot for a south-facing plane with a tilt of 45 degrees to the horizontal. The average ambient temperature during May was 51°F and was equal to the long-term average for May. The number of heating degree-days for the month (based on a 65°F reference) was 403, as compared with the long-term average of 437.

THERMAL PERFORMANCE

System - During May the solar energy system performed approximately the same as expected. The expected performance was determined from a modified f-chart analysis using measured weather and subsystem loads as input. Solar energy used by the system was estimated by assuming that all energy collected would be applied to the load. Actual solar energy used was 3.8 million Btu versus an estimated 4.0 million Btu. System total solar fraction was 94 percent versus an estimated 100 percent.

Collector - The total incident solar radiation on the collector array for the month of May was 36.9 million Btu. During the period the collector loop was operating, the total insolation amounted to 28.4 million Btu. The total collected solar energy for the month of May was 10.9 million Btu, resulting in a collector array efficiency of 30 percent, based on total incident insolation. Solar energy delivered from the collector array to storage was 5.4 million Btu. Energy loss during transfer from the collector array to storage was 5.5 million Btu. This loss represented 50 percent of the energy collected. Operating energy required by the collector loop was 0.14 million Btu.

Storage - Solar energy delivered to storage was 5.4 million Btu and auxiliary energy contribution to storage was 0.090 million Btu. There were 7.9 million Btu delivered from storage to the DHW and space heating subsystems. The storage efficiency was 147 percent: This is calculated as the ratio of the sum of the energy removed from storage and the change in stored energy, to the energy delivered to storage. The average storage temperature for the month was 151°F.

DHW Load - The DHW subsystem consumed 3.7 million Btu of solar energy, 0.053 million Btu of auxiliary energy from storage and 0.12 million Btu of auxiliary electrical energy to satisfy a hot water load of 1.3 million Btu. The solar fraction of this load was 94 percent. Losses from the DHW subsystem were 2.5 million Btu. The DHW subsystem consumed a total of 0.12 million Btu of operating energy, resulting in an electrical energy savings of 3.5 million Btu. A daily average of 58 gallons of DHW was consumed at an average temperature of 146°F delivered from the tank.

Space Heating Load - The space heating subsystem consumed 0.16 million Btu of solar energy, 0.005 million Btu of auxiliary thermal energy from storage, and no auxiliary electrical energy to satisfy a space heating load of 0.17 million Btu. The solar fraction of this load was 93 percent. The space heating subsystem consumed a total of 0.007 million Btu of operating energy, resulting in an electrical energy savings of 0.15 million Btu.

OBSERVATIONS

Data was lost for a 62-hour period at the end of the month due to a power shutdown at the site and also because the phone lines were accidentally cut during construction work. Therefore, no data appear in the report forms for the last three days of May.

Intermittent failure of the flowmeter (W400) in the storage/space heating loop continued throughout the month. The meter intermittently indicated zero flow even though other sensor data show that the related pump (P3) was operating. An estimated flow rate was used on those scans where W400 failed (approximately 15 percent of the scans where flow occurred). Therefore, the performance factors derived from this flow (energy output from storage and heating load) were based, in part, on estimated flow. A replacement sensor is at the site and will be installed by the grantee in June.

Storage efficiency continued to exceed 100 percent by a considerable amount. Since energy input to storage during May was primarily from the collector loop and energy output from storage was primarily to the hot water loop, analysis will focus on these two loops in an attempt to determine the cause of the storage energy imbalance. The high transport losses in the storage/DHW loop (4.1 million Btu) combined with the high losses in the DHW subsystem (65 percent of energy input) suggest that energy measurements in this loop may be high. High measurements in this loop, in addition to explaining the high transport and subsystem losses, would also contribute to the high value for storage efficiency.

The total solar energy delivered to storage during May was 6.9 million Btu. However 1.5 million Btu of this energy was returned by storage to the collector loop during the start-up phase of mode 1, resulting in a net input of 5.4 million Btu of solar energy to storage for the month. Therefore, of the 5.4 million Btu energy loss in the collector loop during mode 1 operation, 1.5 million Btu (28 percent) of the loss was start-up phase losses; the remainder was due to transport losses between the collector array and storage.

ENERGY SAVINGS

The solar energy system provided a total electrical energy savings of 3.5 million Btu. The DHW subsystem provided an electrical energy savings of 3.5 million Btu, while the space heating subsystem contributed an electrical energy savings of 0.15 million Btu.

III. ACTION STATUS

The flow sensor (W400) in the storage/space heating loop will be replaced by the grantee. The replacement meter is at the site.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: MAY, 1979

SOLAR/1029-79/05

SITE/SYSTEM DESCRIPTION:

THE DESIGN CONSTRUCTION SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SOLAR ENERGY SYSTEM USES WATER AS THE COLLECTION, STORAGE AND TRANSFER MEDIUM. HOT WATER FROM THE STORAGE TANK IS TRANSFERRED TO THE DHW TANK THROUGH AN IN-TANK HX. ELECTRICAL ENERGY SUPPLIES AUXILIARY ENERGY FOR HEATING THE DHW. HOT WATER FROM THE STORAGE TANK FOR SPACE HEATING PASSES THROUGH AN ELECTRIC BOILER THEN THROUGH A FOUR ZONE HYDRONIC HEATING SYSTEM.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

36.941 MILLION BTU
46643 BTU/SQ.FT.
10.882 MILLION BTU
13740 BTU/SQ.FT.
51 DEGREES F
74 DEGREES F
0.10 MILLION BTU
0.137 MILLION BTU
0.266 MILLION BTU
11.383 MILLION BTU

SUBSYSTEM SUMMARY:

LOAD
SOLAR FRACTION USED
OPERATING ENERGY
AUX. THERMAL ENERGY
AUX. ELECTRIC FUEL
AUX. FOSSIL FUEL
ELECTRICAL SAVINGS
FOSSIL SAVINGS

HOT WATER
1.324
94
3.655
0.121
0.177
0.124
N.A.
3.534
N.A.

HEATING
0.169
93
0.158
0.007
0.005
0.000
N.A.
0.150
N.A.

COOLING
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL
1.495 MILLION BTU
94 PERCENT
3.812 MILLION BTU
0.266 MILLION BTU
0.183 MILLION BTU
0.124 MILLION BTU
N.A. MILLION BTU
3.548 MILLION BTU
N.A. MILLION BTU

SYSTEM PERFORMANCE FACTOR:

1.152

* DENOTES UNAVAILABLE DATA
2 DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SITE SUMMARY

SITE: DESIGN CONSTRUCTION. BIG FORK. MONTANA
REPORT PERIOD: MAY, 1979

SOLAR/1029-79/05

SITE/SYSTEM DESCRIPTION:

THE DESIGN CONSTRUCTION SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SOLAR ENERGY SYSTEM USES WATER AS THE COLLECTION, STORAGE AND TRANSFER MEDIUM. HOT WATER FROM THE STORAGE TANK IS TRANSFERRED TO THE DHW TANK THROUGH AN IN-TANK HX. ELECTRICAL ENERGY SUPPLIES AUXILIARY ENERGY FOR HEATING THE DHW. HOT WATER FROM THE STORAGE TANK FOR SPACE HEATING PASSES THROUGH AN ELECTRIC BOILER THEN THROUGH A FOUR ZONE HYDRAONIC HEATING SYSTEM.

GENERAL SITE DATA: INCIDENT SOLAR ENERGY

COLLECTED SOLAR ENERGY

AVERAGE AMBIENT TEMPERATURE
AVERAGE BUILDING TEMPERATURE
ECSS SOLAR CONVERSION EFFICIENCY
ECSS OPERATING ENERGY
TOTAL SYSTEM OPERATING ENERGY
TOTAL ENERGY CONSUMED

38.973 GIGA JOULES
529677 KJ/SQ.M.
11.480 GIGA JOULES
156027 KJ/SQ.M.
11 DEGREES C
23 DEGREES C
0.10
0.145 GIGA JOULES
0.280 GIGA JOULES
12.009 GIGA JOULES

SUBSYSTEM SUMMARY:

LOAD
SOLAR FRACTION
SOLAR ENERGY USED
OPERATING ENERGY
AUX. THERMAL ENG
AUX. ELECTRIC FUEL
AUX. FOSSIL FUEL
ELECTRICAL SAVINGS
FOSSIL SAVINGS

HCT WATER
1.397
94
3.856
C.128
C.187
0.131
N.A.
3.728
N.A.

HEATING
0.178
93
0.166
0.008
0.005
0.000
N.A.
0.159
N.A.

COOLING
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.
N.A.

SYSTEM TOTAL
1.577 GIGA JOULES
94 PERCENT
4.022 GIGA JOULES
0.280 GIGA JOULES
0.193 GIGA JOULES
0.131 GIGA JOULES
N.A. GIGA JOULES
3.743 GIGA JOULES
N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR:

1.152

- * DENOTES UNAVAILABLE DATA
- 2 DENOTES NULL DATA
- N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT
OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978,
SOLAR/0004-76/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT

ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA

SOLAR/1029-79/05

REPORT PERIOD: MAY, 1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.694	46	0.169	-0.000	0.001	0.001	0.244
2	1.668	48	0.102	-0.000	0.007	0.007	0.061
3	1.020	51	0.201	-0.000	0.003	0.003	0.197
4	0.164	46	0.132	0.000	0.000	0.000	0.809
5	0.288	45	0.051	0.000	0.000	0.000	0.178
6	0.248	41	0.123	0.083	0.001	0.001	0.485
7	1.752	47	0.218	0.015	0.008	0.008	0.118
8	1.030	46	0.101	-0.002	0.004	0.004	0.093
9	1.807	46	0.053	-0.002	0.007	0.007	0.028
10	0.914	46	0.147	-0.003	0.002	0.002	0.156
11	1.569	51	0.121	-0.001	0.006	0.006	0.075
12	0.964	49	0.103	-0.000	0.003	0.003	0.104
13	1.022	51	0.025	-0.002	0.004	0.004	0.024
14	1.571	52	0.240	0.000	0.007	0.007	0.150
15	1.127	56	0.094	-0.001	0.005	0.005	0.082
16	0.687	51	0.082	-0.001	0.001	0.001	0.117
17	0.999	49	0.163	-0.001	0.005	0.005	0.161
18	0.697	53	0.058	-0.001	0.001	0.001	0.083
19	1.611	54	0.160	-0.000	0.007	0.007	0.098
20	1.540	53	0.119	-0.001	0.006	0.006	0.076
21	1.821	60	0.207	-0.001	0.007	0.007	0.113
22	1.709	60	0.163	-0.000	0.007	0.007	0.095
23	1.638	64	0.094	-0.000	0.006	0.006	0.057
24	0.746	57	0.138	-0.000	0.001	0.001	0.184
25	1.737	59	0.094	-0.000	0.007	0.007	0.054
26	1.741	63	0.066	-0.000	0.007	0.007	0.038
27	1.531	55	0.167	-0.000	0.005	0.005	0.109
28	1.072	46	0.104	-0.000	0.003	0.003	0.097
29	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*
31	*	*	*	*	*	*	*
SUM	36.941	-	3.871	0.090	0.137	N.A.	-
AVG	1.192	51	0.125	0.003	0.004	N.A.	0.103
NBS ID	0001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.

- DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT COLLECTOR ARRAY PERFORMANCE

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/05
REPORT PERIOD: MAY, 1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP -DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.694	0.317	0.063	49	0.091
2	1.668	1.513	0.630	53	0.378
3	1.020	0.649	0.211	56	0.207
4	0.164	0.000	0.000	47	0.000
5	0.288	0.002	0.000	*	0.000
6	0.248	0.000	0.000	*	0.000
7	1.752	1.597	0.733	53	0.418
8	1.030	0.781	0.286	54	0.278
9	1.807	1.581	0.696	54	0.385
10	0.914	0.536	0.065	*	0.071
11	1.569	1.344	0.451	55	0.288
12	0.964	0.576	0.188	*	0.196
13	1.022	0.763	0.193	57	0.189
14	1.571	1.348	0.594	61	0.378
15	1.127	0.955	0.314	*	0.278
16	0.687	0.387	0.043	53	0.062
17	0.999	0.778	0.296	*	0.297
18	0.697	0.341	0.058	56	0.083
19	1.611	1.444	0.640	*	0.397
20	1.540	1.273	0.468	60	0.304
21	1.821	1.590	0.596	65	0.327
22	1.709	1.426	0.597	70	0.350
23	1.638	1.350	0.717	71	0.438
24	0.746	0.246	0.054	58	0.073
25	1.737	1.499	0.618	65	0.356
26	1.741	1.469	0.689	69	0.396
27	1.531	1.277	0.452	*	0.295
28	1.072	0.621	0.176	50	0.164
29	*	*	*	*	*
30	*	*	*	*	*
31	*	*	*	*	*
SUM	36.941	28.412	10.882	-	-
AVG	1.192	0.917	0.351	58	0.295
NBSID	0001		0100		N100

* DENOTES UNAVAILABLE DATA.
DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT STORAGE PERFORMANCE

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA SOLAR/1029-79/05
REPORT PERIOD: MAY, 1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	-0.010	0.294	0.073	151	-35.818
2	0.369	0.230	0.169	152	1.082
3	0.058	0.240	-0.144	154	3.403
4	0.000	0.245	-0.142	140	1.000
5	0.000	0.098	-0.137	128	1.000
6	0.083	0.156	-0.069	119	1.044
7	0.498	0.355	0.291	133	1.257
8	0.137	0.245	-0.039	142	1.500
9	0.413	0.192	0.196	149	0.941
10	-0.019	0.333	-0.157	150	-9.289
11	0.288	0.252	0.107	150	1.246
12	0.116	0.287	-0.126	148	1.380
13	0.048	0.123	-0.008	142	2.416
14	0.411	0.368	0.152	150	1.264
15	0.141	0.206	-0.046	153	1.140
16	-0.035	0.216	-0.123	145	-2.691
17	0.112	0.305	-0.009	141	2.647
18	-0.002	0.178	-0.082	136	-47.137
19	0.430	0.327	0.243	144	1.327
20	0.244	0.245	0.079	158	1.332
21	0.326	0.365	0.079	166	1.362
22	0.306	0.307	0.054	172	1.182
23	0.388	0.224	0.067	176	0.749
24	-0.024	0.254	-0.198	169	-2.332
25	0.326	0.241	0.096	166	1.035
26	0.262	0.242	0.026	171	1.024
27	0.157	0.291	-0.065	171	1.445
28	-0.035	0.218	-0.115	161	-2.945
29	*	*	*	*	*
30	*	*	*	*	*
31	*	*	*	*	*
SUM	5.522	7.903	0.193	-	-
AVG	0.178	0.255	0.006	151	1.466
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
a DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT HOT WATER SUBSYSTEM

SOLAR/1029-79/05

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: MAY, 1979

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR. OF LOAD PER CENT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.064	84	0.169	0.004	0.000	0.000	0.000	0.166	NOT	65	138	87
2	0.024	99	0.102	0.003	0.000	0.000	0.000	0.098		69	140	30
3	0.079	100	0.201	0.004	0.000	0.000	0.000	0.197		64	143	108
4	0.044	100	0.132	0.004	0.000	0.000	0.000	0.129		58	131	69
5	0.005	100	0.012	0.002	0.000	0.000	0.000	0.011		65	124	9
6	0.051	78	0.056	0.001	0.033	0.032	0.000	0.055		65	133	68
7	0.083		0.166	0.004	0.048	0.039	0.014	0.162		57	153	102
8	0.047	83	0.096	0.005	0.018	0.014	0.003	0.092		62	152	59
9	0.006	85	0.051	0.004	0.005	0.009	0.007	0.048		60	150	8
10	0.071	92	0.142	0.006	0.013	0.009	0.004	0.137		64	152	89
11	0.040	91	0.118	0.006	0.011	0.007	0.007	0.114		66	147	51
12	0.041	94	0.100	0.003	0.006	0.005	0.005	0.094		61	154	53
13	0.006	88	0.025	0.003	0.005	0.000	0.000	0.022		61	141	9
14	0.079	96	0.235	0.004	0.005	0.000	0.000	0.232		64	142	112
15	0.042	98	0.092	0.003	0.002	0.000	0.000	0.089		64	140	57
16	0.019	98	0.081	0.004	0.001	0.000	0.000	0.077		61	135	29
17	0.073	98	0.160	0.005	0.002	0.000	0.000	0.155		64	140	112
18	0.015	95	0.058	0.004	0.001	0.000	0.000	0.053		70	125	28
19	0.060	99	0.159	0.006	0.002	0.000	0.000	0.153		70	135	92
20	0.029	99	0.117	0.003	0.001	0.000	0.000	0.114		61	148	42
21	0.063	95	0.206	0.003	0.002	0.000	0.000	0.202		67	150	87
22	0.059	99	0.162	0.003	0.001	0.000	0.000	0.158		70	159	73
23	0.018	99	0.093	0.003	0.001	0.000	0.000	0.090		73	149	24
24	0.045	95	0.137	0.003	0.001	0.000	0.000	0.134		64	160	53
25	0.017	100	0.093	0.004	0.000	0.000	0.000	0.085		68	155	21
26	0.022	100	0.065	0.005	0.000	0.000	0.000	0.060		75	158	27
27	0.049	100	0.167	0.004	0.001	0.000	0.000	0.163		70	158	67
28	0.043	100	0.104	0.004	0.000	0.000	0.000	0.100		61	156	55
29	*	*	*	*	*	*	*	*		*	*	*
30	*	*	*	*	*	*	*	*		*	*	*
31	*	*	*	*	*	*	*	*		*	*	*
SUM	1.324	-	3.655	0.121	0.177	0.124	N.A.	3.534	N.A.	-	-	1794
AVG	0.043	94	0.118	0.004	0.006	0.004	N.A.	0.114	N.A.	65	146	58
NBS	Q302	N300	Q300	G303	G301	G305	G306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT SPACE HEATING SUBSYSTEM

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: MAY, 1979

SOLAR/1029-79/05

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR. OF LOAD PCT.	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	72	46
2	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74	48
3	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	51
4	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	46
5	0.040	98	0.039	0.001	0.000	0.000	0.000	0.038	0.000	71	45
6	0.068	94	0.064	0.003	0.002	0.000	0.000	0.061	0.000	68	41
7	0.045	88	0.040	0.005	0.003	0.000	0.000	0.038	0.000	74	47
8	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	46
9	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	46
10	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	46
11	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	51
12	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	49
13	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	51
14	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	52
15	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	56
16	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74	51
17	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74	49
18	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74	53
19	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	74	54
20	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	53
21	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	60
22	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76	60
23	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	64
24	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76	57
25	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	76	59
26	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	75	63
27	0.000	0	0.000	0.001	0.000	0.000	0.000	-0.001	0.000	74	55
28	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	73	46
29	*	*	*	*	*	*	*	*	*	*	*
30	*	*	*	*	*	*	*	*	*	*	*
31	*	*	*	*	*	*	*	*	*	*	*
SUM	0.169	-	0.158	0.007	0.005	0.000	N.A.	0.150	N.A.	-	-
AVG	0.005	93	0.005	0.000	0.000	0.000	N.A.	0.005	N.A.	74	51
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT ENVIRONMENTAL SUMMARY

SITE: DESIGN CONSTRUCTION, BIG FORK, MONTANA
REPORT PERIOD: MAY, 1979

SOLAR/1029-79/05

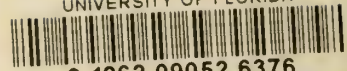
DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	877	N	46	49	N	N	N
2	2106	C	48	53	O	T	T
3	1288		51	56			
4	207		46	47			
5	364		45	*			
6	313		41	*			
7	2212		47	53			
8	1300		46	54			
9	2282		46	54			
10	1155		46	*			
11	1981		51	55			
12	1217		49	*			
13	1290		51	57			
14	1984		52	61			
15	1423		56	*			
16	868		51	53			
17	1261		49	*			
18	880		53	*			
19	2035		54	*			
20	1944		53	60			
21	2299		60	65			
22	2157		60	70			
23	2068		64	71			
24	942		57	58			
25	2193		59	65			
26	2199		63	69			
27	1933		55	*			
28	1353		46	50			
29	*		*	*			
30	*		*	*			
31	*		*	*			
SUM	46643	N.A.	-	-	-	-	-
AVG	1505	N.A.	51	58	N.A.	N.A.	N.A.
NBS ID	0001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.

@ DENOTES NULL DATA.

N.A. DENOTES NOT APPLICABLE DATA.

UNIVERSITY OF FLORIDA



3 1262 09052 6376